

CORRECTED VERSION

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
28 October 2004 (28.10.2004)

PCT

(10) International Publication Number  
**WO 2004/093324 A1**

(51) International Patent Classification<sup>7</sup>: **H03M 3/00**

[NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). REEFMAN, Derk [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(21) International Application Number:  
PCT/IB2004/050424

(74) Agent: ELEVELD, Koop, J.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(22) International Filing Date: 13 April 2004 (13.04.2004)

(25) Filing Language: English

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(26) Publication Language: English

(30) Priority Data:  
03101036.6 16 April 2003 (16.04.2003) EP

(71) Applicant (*for all designated States except US*): KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

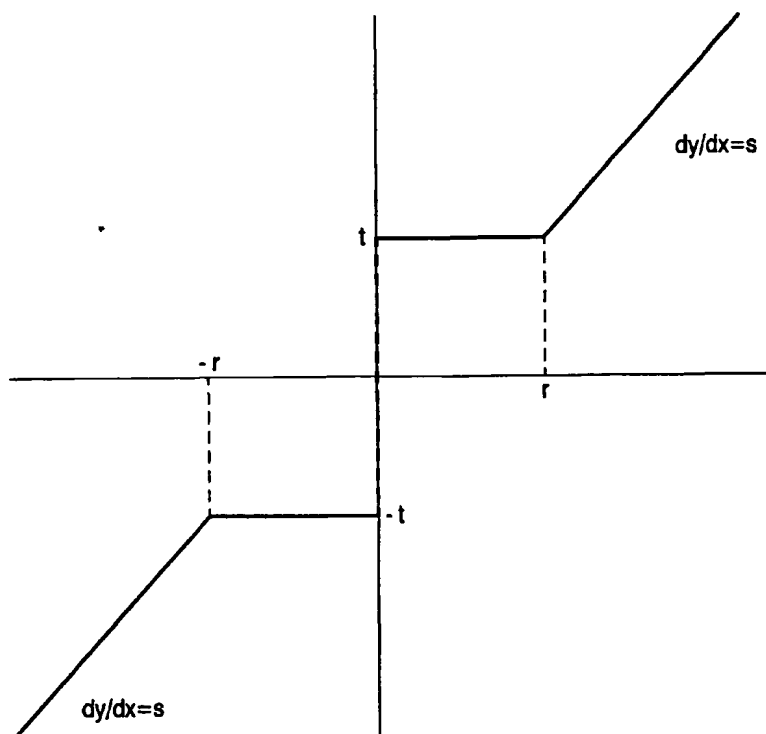
(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): JANSSEN, Erwin

[Continued on next page]

(54) Title: SIGMA-DELTA MODULATOR



(57) Abstract: A sigma-delta modulator (SDM) including  $n$  ( $n \geq 1$ ) integrators in series, where a first of the  $n$  integrators receiving an input signal, at least one Q device, which acts as a quantizer when an absolute value of a signal input thereto is smaller and as a gain element (either with or without offset) when the absolute value of the signal input thereto is larger, and a device for quantizing an output of the unit. The SDM may be a feed back or feed forward SDM. The SDM may include a single or multiple Q devices. The single Q device may be positioned so that the signal input to the one Q device is an output of the last integrator and the output of the one device  $Q_1$  is input to the device for quantizing and/or to the  $n$  integrators. For multiple Q devices, each of the Q devices may have different parameters set to improve stability, improve SNR, and/or reduce introduction of artifacts. The SDM may be part of an analog to digital converter and/or a digital to digital converter. The SDM may process digital or analog signals, for example, a 1-bit signal.

WO 2004/093324 A1



Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— with international search report

**(48) Date of publication of this corrected version:**

29 December 2004

**(15) Information about Correction:**

see PCT Gazette No. 53/2004 of 29 December 2004, Section II

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International Application No  
/IB2004/050424

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 H03M3/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 H03M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 064 326 A (KRONE ANDREW W ET AL) 16 May 2000 (2000-05-16) columns 1-10; figure 6	1-16
A	US 6 424 279 B1 (KIM BEOMSUP ET AL) 23 July 2002 (2002-07-23) column 1 - column 5; figure 4a	1-16
A	US 6 157 331 A (POH DAVID HO SENG ET AL) 5 December 2000 (2000-12-05) column 1 - column 8; figure 1	1-16

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*G\* document member of the same patent family

Date of the actual completion of the international search

16 July 2004

Date of mailing of the international search report

28/07/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Morrish, I

# INTERNATIONAL SEARCH REPORT

ational Application No  
/IB2004/050424

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6064326	A	16-05-2000	NONE	
US 6424279	B1	23-07-2002	KR 2001003899 A	15-01-2001
US 6157331	A	05-12-2000	NONE	